



Figure 4. Aerial photo of Brookhaven's Alternating Gradient Synchrotron. This proton accelerator lies in a tunnel under the circular mound at top left.

proach, which allowed drastic reductions in the size of an accelerator's vacuum pipes and magnets, is now employed in virtually every major particle accelerator. In previous machines like the Cosmotron, particle beams spread out when accelerated, requiring a wide "bore" on the vacuum pipes carrying them and hence, large magnets surrounding these pipes. With strong focusing, however, the beam pipes could be just a few inches in diameter and the magnets much smaller too, resulting in great savings in construction costs.

Among the first machines to use strong focusing was the Alternating Gradient Synchrotron, or AGS, a 30 GeV proton accelerator built with AEC funding at Brookhaven. About a kilometer in circumference, this synchrotron could not fit in a single large building like the Cosmotron and Bevatron. Instead it was housed in a circular tunnel under a mound of earth. Completed in 1961, the AGS is still in operation today. One of the most productive scientific instruments ever built, its par-

ticle beams have been used to make three Nobel prize-winning discoveries, and still are in use today.

With the AGS, physicists could begin producing beams of neutrinos. To do this they smashed high-energy protons from the AGS into a metal target, generating copious quantities of pions that subsequently decayed in flight, yielding muons and neutrinos. Filtering out the charged particles by passing all this debris through a thick stack of iron plates, they were finally able to produce a pure beam of neutrinos.

A team of Brookhaven and Columbia University physicists led by Leon Lederman, Melvin Schwartz, and Jack Steinberger studied these neutrinos in 1962 to determine whether there was only one or actually two different kinds. Were the neutrinos emerging from disintegrations of atomic nuclei exactly the same beasts as those that escaped from decaying pions? These physicists proved that